– Postdoctoral Position at LAM –

Coupling High-Dispersion Spectroscopy and High-Contrast Imaging

Location: Laboratoire d'Astrophysique de Marseille (LAM; https://www.lam.fr/)
Funding: ERC HiRISE (PI Arthur Vigan, grant agreement #757561)
Duration: up to 3 years
Starting date: 1 December 2017 or 1 January 2018
Deadline: 31 October 2017

Supervisor: Arthur Vigan (CNRS/LAM)
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Summary

A postdoctoral position supported by the ERC HiRISE (High-Resolution Imaging and Spectroscopy of Exoplanets) is offered at Laboratoire d'Astrophysique de Marseille (France) to work with Dr. Arthur Vigan on the fiber coupling of VLT/SPHERE and VLT/CRIRES+ to enable the characterization of young giant exoplanets at very high spectral resolution.

Context

Atmospheric composition provides essential markers of the most fundamental properties of giant gaseous exoplanets, such as their formation mechanism, formation location in the protoplanetary disk or internal structure. New-generation exoplanet imagers equipped with extreme adaptive optics, like VLT/SPHERE or Gemini/GPI, have been designed to achieve very high contrast (>10 mag) at small angular separations (<0.5") for the detection of young giant planets in the near-infrared, but they only provide very low spectral resolutions (R<100) for their characterization. Their measurements can be used to constrain the basic atmospheric properties of the planets, like effective temperature or surface gravity, but their low resolution often leads to degeneracies when fitting physical models and does not allow focused measurements like abundances determination.

High-dispersion spectroscopy at resolutions up to 10^5 is one of the most promising pathways for the detailed characterization of exoplanets, but it is currently out of reach for most directly imaged planets. The power of high-dispersion spectroscopy lies in the ability to disentangle the stellar and planetary signals using the distinct radial velocity component of the planet that originates from its orbital motion. However, this differential radial velocity can only be measured by overcoming the large contrast ratio between the star and the planet. Self-luminous, young giant planets potentially constitute ideal targets because of their intrinsic brightness in the near-infrared, but current high-dispersion spectrographs in the near-infrared lack coronagraphs to attenuate the stellar signal or the spatial resolution necessary to resolve the planet.

ERC project HiRISE will bring high-spectral resolution to SPHERE by implementing a prototype fibre coupling with CRIRES+, the high-dispersion near-infrared spectrograph for the VLT. The project will explore the key instrumental and astrophysical aspects of the coupling using theory, instrumental and astrophysical simulations, modelling, and laboratory validation of components and methods on our high-contrast imaging testbed (MITHIC). Data acquired on-sky with the prototype will be used to answer cutting-edge astrophysical questions on young giant exoplanets.

More information on HiRISE: http://astro.vigan.fr/hirise.html

Postdoctoral work

The successful applicant will be at the heart of HiRISE.

(S)He will be in charge of developing the simulation framework that will be used to define the top-level requirements of the HiRISE prototype, investigate its expected performance and explore the science cases that will be addressable by the system.

Several steps in the development are foreseen:

- Initial photometric model for order of magnitudes estimations
- Complete end-to-end model with full propagation
- Interaction with wavefront control techniques to optimize fiber injection
- Detailed simulation of fiber propagation

The goal will be to simulate realistic data for the SPHERE/CRIRES+ system, including the fiber injection and transmission, that will be used to dimension the prototype and work on innovative signal extraction. The simulation model will include both astrophysical and instrumental parameters that can be adjusted to explore multiple science cases. Existing SPHERE simulation tools will be used as a starting point and will be extended towards a more realistic modelling and higher-spectral resolution. The development work will be done in collaboration with both instrumentalists and astronomers who have been involved in the development of VLT, Gemini and Keck instrumentation.

Once a working version of the simulation framework is available, the applicant will be able to diversify his/her work either towards instrumental aspects with a participation to laboratory validations of fiber injection and wavefront control on the MITHIC high-contrast imaging testbed at LAM, or towards astrophysical aspects related to the signal extraction and interpretation from high-spectral resolution data. The simulation model will be a cornerstone for subsequent studies in HiRISE and next-generation instrumentation.

If (s)he wishes, the applicant will have the opportunity to supervise Master students on summer projects as well as participate to the supervision of one of the two PhD students foreseen in the HiRISE project.

The project will be primarily done at LAM, at the interface between the instrumental R&D group (GRD) and the planetary system group (GSP). The successful application will benefit from the local expertise in adaptive optics, high-contrast instrumentation and exoplanets. Strong collaborations with external partners are foreseen, with possibilities for short- or long-term visits during the post-doctoral work.

Requirements / Profile

Minimum qualifications include a PhD degree in astronomy, physics, optics or related fields. Skills in signal processing and data analysis will be useful. Proficiency in Python, IDL or similar data analysis software is necessary.

The applicants must have demonstrated their capacity for independent work and for conducting independent research.

Application

Applicants should send a PDF file by e-mail containing:

- A one page letter of motivation;
- A curriculum vitae and list of publications;
- A short (2 pages) statement of research and experience;

to Arthur Vigan (arthur.vigan@lam.fr).

Please also arrange for up to 3 letters of reference to be e-mailed directly.

Applications sent before 31 October 2017 will receive full consideration. Past this date applications will be considered upon availability of the position. Junior and senior applications will be evaluated at the same level. LAM and CNRS are actively committed to equal opportunity in employment.

Benefits

The position comes with generous funding for travels, missions and conferences (both national and international).

Gross salaries range between 30k€ and 35 k€ per year depending on experience and are subject to income tax. The position comes with full social benefits covered by the French social security system.